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Biological weapons from the physician's point of view.

by H. Schulz-Utermoehl.

Wehrmedizinische Mitteilung 3/1957, 26-28. Supplement to Truppenpraxis 10/1957.

In treating the subject of possible biological warfare, we enter upon a theoretical field, as the governments of the people have agreed by a convention to renounce the use of poison gas and bacteriological weapons. In 1954 an alleged offense against this agreement was followed by a protest from the Soviet Union and a subsequent exchange of notes between the Western Powers and Soviet Russia. Nevertheless, it seems indicated to initiate theoretical considerations about the biological foundations of bacteriological weapons, for it would be a criminal neglect of duty and foresight, the latter representing an active factor in military planning as well as in medical procedure, if no attempt were made to understand the effect and the potential of bacteriological weapons. Their technical production lies outside the area of interest and the sphere of influence of the medical officer.

It must be assumed on the basis of various indications that such weapons of the biological type have been planned and tested for their effective potential in various quarters. Thus, during the opening of a laboratory at Cambridge 10 years ago, it was announced that biological weapons had been developed and tested. Their effect was said to be as destructive to human life as that of atomic weapons, and their action far more insidious. The press treated the same theme under the headline "The world's top secret is a microbe" and discussed the possible use of bacteriological weapons. Such publications serve to evoke apprehension among the populace, as the anticipated victims of these weapons. The absence of concrete conceptions about practical possibilities and biological foundations, the account of fatalities in epidemics of past history and the aforesaid types of publications by the daily press jointly have led to the widespread fear of biologically effective weapons. There are historically reliable reports of the decisive effect of epidemics in campaigns of past centuries. The knowledge of these historical facts may have contributed to the decision to investigate the possible use of biological agents from the aspect of modern warfare. The results of these investigations are being guarded as military secrets. One may deduce therefrom that they are considered to be important and promising. However, the pertinent manuals of foreign armies show that the possibilities attributed to bacteriological weapons are being overestimated, at least as far as their suitability as agents of mass destruction is concerned. No decisive effects or revolutionary, new tactical doctrines will result from their possible employment.

The term "biological weapons" encompasses agents of various type, whose point of attack may be animated nature in its entirety. Depending on their type, these agents may be vital or may represent poisons (toxins)

caused and produced by living organisms. A differentiation is therefore made between organic and toxic types of biological weapons. They differ in their employment, the potential of their employment and their effect. Naturally such weapons may also be committed against the animal and plant kingdoms.

Let us examine the natural defenses available to man as a target of biological warfare, and deduce therefrom how such weapons must be constructed in order to become effective. Man as a living being is constantly doing battle with his animate and inanimate environment. This environment also includes the microorganisms. Many types belong to the natural element of man and only a very few cause diseases if they are able to overcome the complicated and efficient human defensive mechanism.

These natural defensive powers, based on the species *Homo sapiens*, are reinforced by acquired shields. They may develop in the course of a disease as the result of the battle between the body and the intruding pathogen, or as a consequence of vaccination. This defensive mechanism, in contrast to natural resistance, is aimed, i.e. it is effective only against the specific causative agent that called it forth. These protective measures, depending as they are on the blood (serologic) and the cells (cellular) are joined by the intact skin. The skin is mechanically impregnable to most pathogens and destroys ever-present airborne germs chemically by means of its acid coating. The mucous membrane, on the other hand, is far more easily penetrated; the respiratory passages serve a number of submicroscopic pathogens (virus) as a natural portal of entry. Due to the defensive mechanism, only a certain part of the persons coming in contact with the causative agents actually become ill. The presence of a known pathogen is not equal to a clinical disease. Therefore the equation pathogen = disease does not exist.

The manner in which such an individual infectious case leads to an epidemic is far more difficult and obscure. The transformation of a chance focus of infection into a group illness and its further elaboration into a mass affliction -- an epidemic -- is a complicated chain reaction. Epidemiology is trying to identify the individual links in as continuous a chain as possible. Every epidemic spreads according to its own rules. The last connections of the epidemic process have been clarified but in the case of a few epidemic diseases. A large number of individual factors, such as disposition, saturation, season, climate, weather, contribute to the genesis of an epidemic. The matter becomes even more complicated if epidemics are involved that are not limited to man, but require an animal as intermediary host for transmission, e.g. the plague or malaria. Thus the liberation of rats infected with plague bacilli would not lead to a plague epidemic.

The situation changes if, instead of considering the dissemination of a primary focus by means of bacteriological weapons in the light of an epidemic, a mass affliction with these agents is desired. The artificial production of epidemics, which spread according to inherent rules after the creation of a primary focus, is not a soluble problem for military operations. On the other hand, a large number of persons may be directly and artificially infected. The basis of such a massive infection is the epidemiological concept of the contagion index. It is a technical term for the probability of infection.

The natural defensive power of man against certain pathogens has already been discussed. The larger the number of persons who become ill upon contact with the causative agent, the higher the contagion index. If everyone becomes ill, the contagion index is 1.0. The higher the contagion index, i.e. the closer it approaches the number 1.0, the lower the natural resistance of the organism vis-a-vis this particular pathogen. We know of diseases in which the contagion index is nearly 1.0, e.g. measles, infecting every person coming in contact with the pathogen. Nevertheless we do not fear it as much as poliomyelitis. This disease has a contagion index of only 0.001. Of 1,000 infected persons, only one becomes clinically ill. There are pathogens among the group of ultra-visible viruses which -- like measles -- meet the above requirements. They enter the organism by the path of least resistance, i.e. via the respiratory tract; they are transmitted by dust, they possess a sufficient resistance to the physical influences of their surroundings and have a contagion index of nearly 1.0. These properties make them suitable for employment as biological weapons. It is possible to immunize against virus diseases. This requires their identification. There is no protection against new virus diseases. While friendly troops may be protected even against a modified virus, they are helplessly exposed to the enemy's agent. Moreover, the factor of surprise would be almost eliminated by the immunization of friendly troops and the required large-scale organizational measures connected therewith. The employment of organic agents is impossible without corresponding vaccination. Their commitment is possible only against a limited area. The target will be a large aggregation of persons on a few square kilometers, a combat or social group (naval ship, air base, the civilian population of a large city), but not troops dispersed over a large area. Individual casualties may therefore be inflicted with bacterial agents and massive infections with viral agents, but an epidemic that follows its own laws cannot be consciously developed with organic weapons.

The possibilities of biological weapons are not exhausted herewith. The effect of many types of microorganisms on the human body is exerted through poisons, so-called toxins. The strongest toxins occurring in nature are formed by the members of a bacterial group that has had a disastrous part in past wars. They include the pathogens of tetanus, gas gangrene and botulism. Toxins are products of bacterial metabolism and are lethal even at great dilutions when properly dispensed. They all share the property of remaining latent for various periods of time. Research made public in other countries is aimed at the production of first-rate bacterial toxins. The toxin is contained in the culture liquid. According to the literature, concentrations have been developed so high that a single cubic centimeter of this liquid suffices to kill 50,000 to 80,000 persons. The lethal dose per kilogram of body weight is set at 10^{-7} g. However, these toxins are effective only if they reach the blood stream either directly or by way of the gastro-intestinal canal and other mucous membranes. These toxins may be dried. Their chemical constitution is unknown. They are harmless when placed on the unimpaired skin. Heating to 100°C destroys them. Different types of the same pathogen are known to produce different toxins. A specific antitoxin or antidote exists against each one. Only the proper antitoxin is efficacious. These antitoxins are prepared in animal organisms and dispensed in the form of serum. Symptoms may be prevented only by timely

instillation of antitoxin. Since these appear at a time when the toxin has already established itself in the body, antitoxin prescriptions frequently are too late. The difficulties lie in determining whether and when toxins have gained access and the type of toxin involved. The peculiarity of bacterial toxins lies in the circumstance that they become ineffective after a certain period of time, so that friendly troops would not be endangered during an advance.

Due to the multiplicity of application, this field represents a considerably greater danger than the aforementioned organic agents. Toxins may be dispersed when dry and are equally effective via the drinking water when wet. There is no natural resistance to them. They act identically in every person when instilled in sufficient quantities.

The next question concerns the delivery of these weapons. Firstly, it may take place in a deliberate, aimed manner, as is being done in connection with aerial spreading of insecticide. Large areas may be sprayed from the air with sufficient concentrations of toxins. It must be assumed that the experience gained in this field is sufficient to guarantee success in the employment of biological weapons, organic as well as toxic. The second possibility is represented by unaimed delivery in the form of a bacterial (organic) or toxic mist, driven by winds. Every type of employment may be used according to the situation. Taking everything into consideration, biological weapons are deemed to be instruments of sabotage rather than media of mass destruction in the customary sense.